

THE "METEOR" SPACE SYSTEM

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16. Abstract The Soviet experimental "Meteor" weather satellite system, developed in 1967, was designed to improve accurate long-range global weather forecasting. The operation of the satellite and earth-based data collection, transmission and processing systems is discussed. The system incorporates television, infrared and actinometric instruments.			
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THE "METEOR" SPACE SYSTEM

The development of the technology and economy of the Soviet Union also /2*
places new requirements on meteorology. Only recently weather forecasts were issued in support of the economic activity of relatively small regions of the country. But now, with the development of scheduled air routes to remote places of the Soviet Union and to countries of the other hemisphere of the earth, with the organization of intercontinental flights to Antarctica, with the development of maritime transportation and expanding activity of the fishing fleet in all the world's oceans, complete information about the hydrometeorological situation and its forthcoming changes on a global scale is essential. It has been calculated that reliable forecasts, even 2 weeks in advance, will make it possible to save tremendous national resources.

Accurate long-range weather forecasts requires the development of a theory of general atmospheric circulation, which in turn is impossible without systematic meteorological observations of the entire surface of the planet.

However the nearly 10,000 weather stations that now exist on the earth do not suffice for the solution of this problem. They cannot provide information from the enormous expanses of the oceans, there are too few of them in remote regions of the continents and on the ice covered reaches of the Arctic and Antarctic. Nearly 80% of our planet is still a blank spot as far as meteorology is concerned.

Only a weather satellite, equipped with special apparatus, continuously flying above the earth, can provide from the altitude of its orbit information

*Numbers in the margin indicate pagination in the foreign text.

about the weather over the entire planet. But even the gathering of such information in itself is not yet the solution to the problem. It is essential that this information be subjected to immediate processing and that it be relayed immediately for operational work.

The experimental "Meteor" orbiting meteorological system was developed in the Soviet Union in 1967. It consists of weather satellites, earth-based meteorological data receiving, processing and dissemination complex, and also a service for monitoring the condition and controlling the operation of onboard satellite systems.

Soviet weather satellites were developed in accordance with the program made public by TASS on 16 March 1962. Their developed required solutions for many complex scientific and engineering problems.

A weather satellite consists of two sealed compartments: instrument compartment, located in the lower part of the satellite and containing scientific apparatus, and power compartment, in which are housed the main service systems. To this compartment is structurally connected electric drive mechanism that operates the solar battery panels, which unfold after the satellite separates from the booster.

The large area of the solar batteries provides electrical power for all the apparatus of the satellite for many months of operation.

The longitudinal axis of the satellite is always aimed toward the center of /3 the earth. The satellite is also oriented on two other axes, directed along the trajectory and perpendicular to the orbital plane. The continuously operating electromechanical system maintains constant orientation and stabilization of the satellite. Another independent drive system constantly keeps the solar batteries perpendicular to the rays of the sun. The orientation of the axis of the satellite is controlled by sensors that pick up the thermal radiation of the earth, and special photocells are employed for orientation of the solar batteries. The thermal control system ensures the required operating mode inside the satellite.

Weather data are recorded by onboard data storage systems and are later transmitted to the earth-based stations. The data, accumulated during several

orbits, can be transmitted in a few minutes by command from the earth or by means of a programmed system.

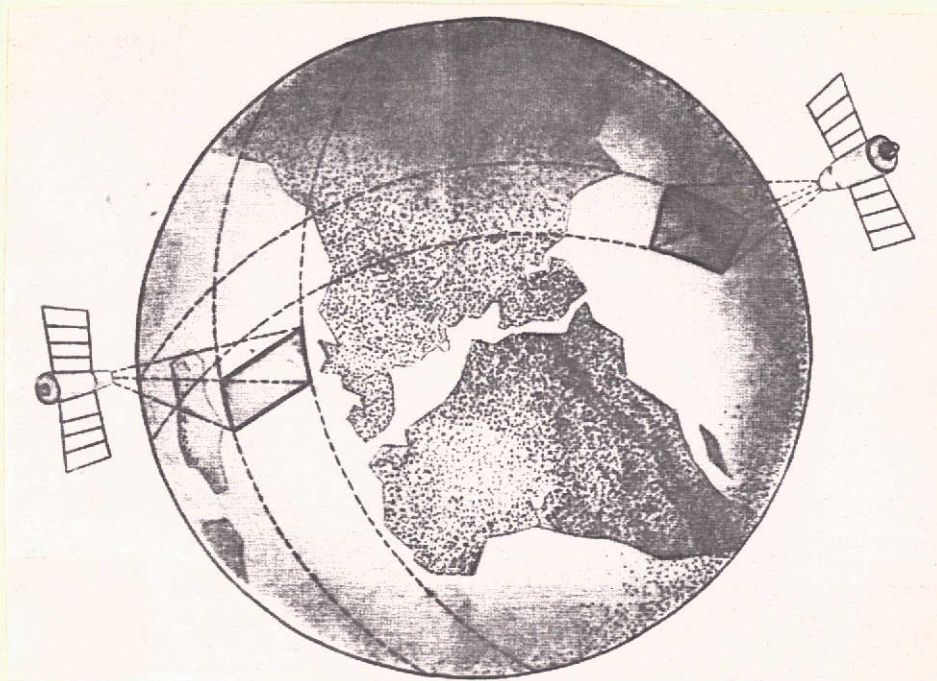


Figure 1. Mutual Arrangement of Satellite Orbits.

The meteorological apparatus of the satellite consists of a television camera (TV), infrared (IR) and actinometric (AC) apparatus. This apparatus operates in cycles of varying duration and is shut off by a program or on command from the earth.

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The TV system is designed for observing the cloud cover on the daylight side of the earth (with the sun at least 5° above the horizon). Photography is conducted with two cameras, one of which photographs the right, and the other the left side of the band along the route of the satellite. The photographs yield information about the type and quantity of the cloud cover. The field of view of the television cameras occupies a band of about 1,000 km, and resolution at the center of the frame is 1.25×1.25 km.

The IR scanning system is used for observing the cloud cover on the night side. It is sensitive to the radiation flux in the $8-12 \mu$ portion of the spectrum. The magnitude of this radiation is determined only by the temperature

of the clouds or the earth's surface and does not depend on reflected solar radiation. Therefore the IR system permits observation of clouds on both sides of the earth, day and night. The width of the field of view is about 1,000 km and resolution at the center of the frame is 15×15 km.

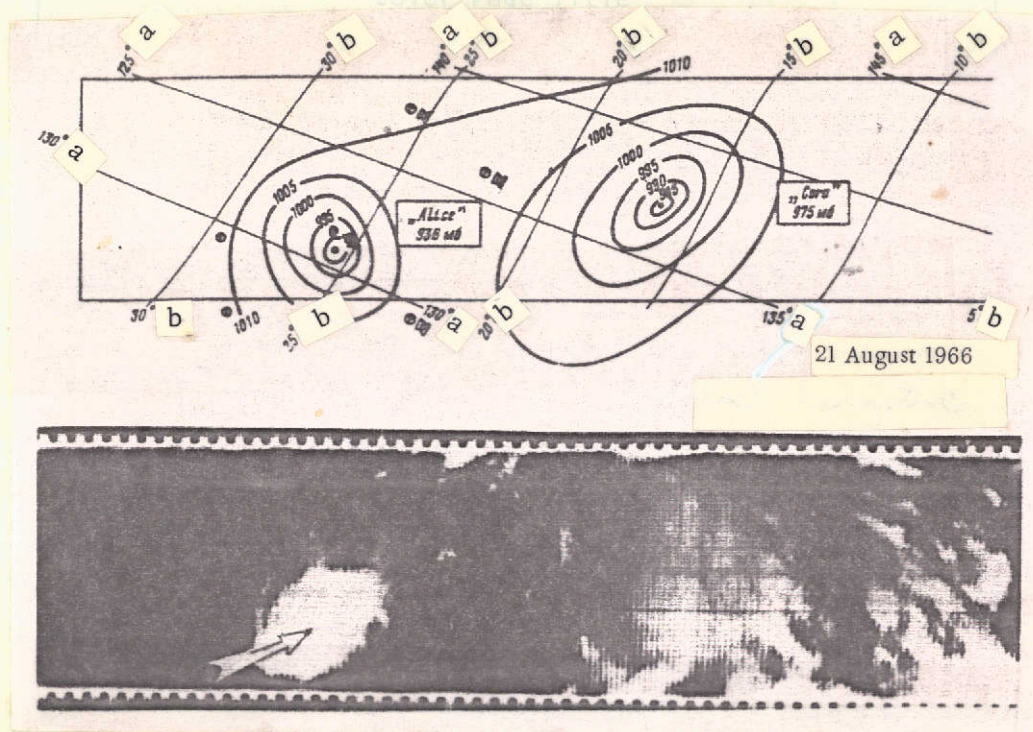


Figure 2. Typhoons "Alice" and "Cora" Detected in the Pacific Ocean by Soviet Weather Satellite. Below are images taken from aboard the satellite, and above is their processing. a, East longitude; b, north latitude.

The TV and IR photographs show structural features of cloud fields that are invisible to the observer on the ground, and provide conclusions not only concerning the position, but also the evolution of the corresponding synoptic objects and air masses. The combined TV and IR information afford a more reliable evaluation of the synoptic situation and character of development of atmospheric processes.

The AC system is designed for measuring radiation emanating from the earth. It consists of two scanning narrow band instruments, one for the 0.3 to 3μ range and the other for the $3-30 \mu$ and $8-12 \mu$ ranges. This makes it possible to analyze the reflective and emissive properties of clouds and cloudless regions of the earth's surface, and also the radiation balance of the

earth-atmosphere system. Measurements in the $8-12 \mu$ range make it possible to determine the temperature (and consequently the altitude) of the top boundary of the clouds and of individual parts of the earth. On the basis of radiation data it is possible to make conclusions concerning the presence of cyclones, atmospheric fronts, etc. The width of the band that can be viewed with these instruments is about 2,500 km and resolution is 50×50 km.

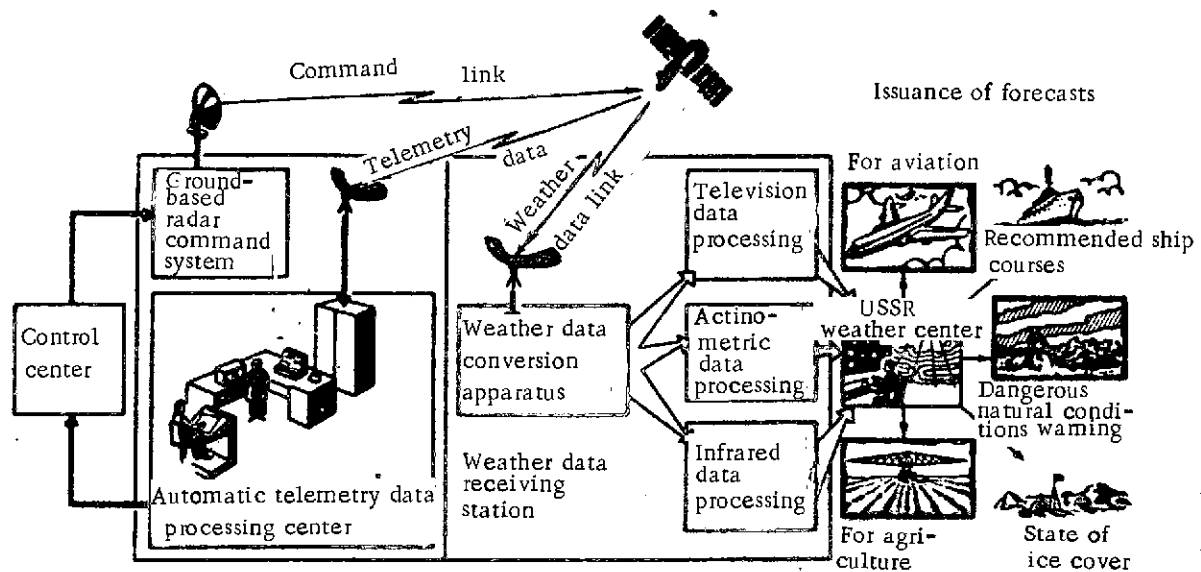


Figure 3. Diagram of "Meteor" System.

The AC equipment also includes two wide-sector instruments that measure the flux in the $3-30 \mu$ range. They cover with their measurements the entire disc of the earth visible from the satellite.

In just one orbit around the earth the satellite receives TV and IR information from about 8% of the earth's surface and information about radiation fluxes from about 20% of the earth's surface. A system of two satellites in circular polar orbits at an altitude of 625-630 km, the orbital planes of which intersect at an angle of about 95° , provide information from one-half of the earth's surface in a 24-hour period. Each region of the planet is observed with an interval of 6 hours.

The Soviet Union has also developed a ground-based weather data collection, processing and dissemination system, designed for operational conditions. At

the ground-based stations the information is fed into computers. As a result of operation the TV and IR data are received in the form of photographs, on which are superimposed a grid of geographic coordinates that are free of possible distortions, reduced to the same scale and convenient for comparison with synoptic charts. During analysis the boundaries of the cloud fields and the characteristics of the clouds are established with the aid of the photographs.

The results of processing of AC data are represented in the form of numerical charts, on which is automatically superimposed a coordinate and iso-line grid. /6

The processed information is assembled by the hydrometeorological service of the Soviet Union. It is used extensively in the operations of the subdivisions of the Soviet weather service and for international exchange. Analyses of synoptic charts and 1-3 day weather forecasts are refined on the basis of the data received from the satellites. Of particularly great importance are satellite information for analyzing weather conditions above a sparse network of weather stations and ice reconnaissance over regions of the Arctic Ocean for navigation in the North Sea lane.

The development and successful operation of the "Meteor" meteorological space system are one form of direct application of Soviet space research for the benefit of the Soviet people.

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